

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A process comprising:
- (a) extruding melted 3GT through a spinneret;
- (b) quenching the extruded 3GT to form a threadline of solid
 filaments wherein the filaments have a tension at 130°C greater than
 about 0.02 g/d;
- 10 (c) passing the filaments to a heated godet operated at a
 speed and temperature to heat the threadline wherein the speed and
 temperature to which the threadline is heated are sufficient to provide a
 yarn with a DWS value of about 4% or less; and
- (d) cooling the yarn to a temperature of about 35°C or less.
- 15 2. The process of claim 1, wherein a finish is applied to the solid
 filaments after quenching.
3. The process of claim 1, wherein the cooling is accomplished
- 20 using a cool godet.
4. The process of claim 3, wherein the speed of the cool godet
 provides a draw ratio between the heated godet and the cool godet of about
 1.04 or less.
- 25 5. The process of claim 3, wherein the threadline from the cool
 godet is wound on a package.
6. The process of claim 5, wherein the winding is such that the true
- 30 yarn speed is less than the speed of the cool godet.

7. The process of claim 3, wherein the threadline tension is increased before passing to the cool godet.

8. The process of claim 7, wherein the threadline tension is increased by at least about 0.005 g/d.

9. The process of claim 8, wherein the threadline tension is increased by at least about 0.010 g/d.

10. The process of claim 9, wherein the threadline tension is increased by at least about 0.015 g/d.

11. The process of claim 3, wherein the speed of the heated godet is at least about 3000 m/m.

12. The process of claim 11, wherein the temperature of the heated godet is about 90°C to about 165°C.

13. The process of claim 12, wherein the temperature of the heated godet is about 115°C to about 160°C.

14. The process of claim 13, wherein the temperature of the heated godet is about 125°C to about 155°C.

15. The process of claim 4, wherein the draw ratio between the heated godet and the cool godet is less than about 1.02.

16. The process of claim 15, wherein the draw ratio is about 1.0 or less.

17. The process of claim 5, wherein the filaments are wound on a package at a tension greater than about 0.04 g/d.

18. The process of claim 17, wherein the filaments are wound at a tension greater than about 0.05 g/d.

19. The process of claim 17, wherein the filaments are wound at a
5 tension less than about 0.12 g/d.

20. The process of claim 19, wherein the filaments are wound at a tension less than about 0.10 g/d.

10 21. The process of claim 17, wherein the filaments are wound at a tension less than about 0.08 g/d.

22. The process of claim 20, wherein the filaments are wound at a tension less than about 0.08 g/d.

15 23. Melt spun poly(trimethylene terephthalate) yarn, having a DWS of about 4% or less.

20 24. The yarn of claim 23, wherein the DWS is about 2% or less.

25. The yarn of claim 23, having an elongation less than or equal to about 105%.

26. The yarn of claim 23, having a tenacity equal to or greater than
25 about 2.5 g/d.

27. The yarn of claim 23, having a modulus of less than or equal to about 23 g/d.

30 28. The yarn of claim 23, having an Uster of less than or equal to about 2%.

29. The yarn of claim 23, having a boil off shrinkage of less than or equal to about 14%.

30. The yarn of claim 29, wherein the boil off shrinkage is less than
5 about 10%.

31. The yarn of claim 23, having a Tension at 130°C of equal to or greater than about 0.02 g/d.

10 32. The yarn of claim 23, having a first thermal tension peak temperature of about 60 - 90°C.

33. The yarn of claim 32, having a first thermal tension peak temperature of about 65 - 90°C.
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34. The yarn of claim 23, having a first peak tension of about 0.03 – 0.15 g/d.

35. The yarn of claim 34, having a first peak tension of about 0.03 –
20 0.10 g/d.

36. The yarn of claim 23, having a shrinkage onset temperature of about 45°C to 70°C.

25 37. The yarn of claim 36, having a shrinkage onset temperature of about 50°C to 70°C.

38. A wound package of melt spun poly(trimethylene terephthalate) of Claim 23, having a thickness of yarn layer of at least about 50 mm and a
30 package weight of at least about 6 kg.

39. The package of claim 38, having a thickness of yarn layer of at least about 63 mm and a package weight of at least about 8 kg.

40. The package of claim 39, having a thickness of yarn layer of at least about 74 mm and a package weight of at least about 10 kg.

41. The package of claim 40, having a thickness of yarn layer of at least about 84 mm and a package weight of at least about 12 kg.

42. The package of claim 41, having a thickness of yarn layer of at least about 94 mm and a package weight of at least about 14 kg.

43. A package made from the yarn of claim 23, having a thickness of yarn layers of at least about 16 mm, weighing at least about 1.5 kg and having a package diameter of at least about 142 mm, which upon exposure to temperatures of at least 41°C for at least 3.2 hours, has a dish ratio of about 0.82% or less.

44. A package made from the yarn of claim 23, having a thickness of yarn layers of about 20 – 30 mm, weighing about 2 - 3 kg and having a package diameter of about 151 - 169 mm, which upon exposure to temperatures of at least 41°C for at least 3.2 hours, has a difference between package end and mid diameters of about 2mm or less.

45. The package of claim 44, which upon exposure to temperatures of 41°C for at least 3.2 hours has a dish ratio of about 0.44% or less, or the difference between package end and mid diameters of about 1.1 mm or less.

46. The package of claim 44, which upon exposure to temperatures of 41°C for at least 3.2 hours has a bulge ratio of about 5% or less.

47. The package of claim 38, having a bulge ratio of less than about 9%.
48. The package of claim 47, having a bulge ratio of less than about 7%.
49. The package of claim 48, having a bulge ratio of less than about 6%.
50. The package of claim 38, having a dish ratio about 2% or less.
51. The package of Claim 5 having a dish ratio of about 1% or less.
52. The package of claim 38, wound about a tube, which is substantially free of crush.
53. A method comprising:
- (a) measuring the unstretched length of a yarn as L_1 ; heating the yarn for a time and under a temperature sufficient for the yarn to attain at least 85% of its equilibrium shrinkage,
 - (b) cooling the heated yarn;
 - (c) measuring the unstretched length of the cooled yarn as L_2 ; and
 - (d) calculating the dry warm shrinkage (DWS) of the yarn using

$$\text{DWS} = \frac{L_1 - L_2}{L_1} \times 100$$

54. The method of claim 53, wherein the heating temperature is about 30 to 90°C.

55. The method of claim 54, wherein the heating temperature is about 38 – 52°C.

56. The method of claim 55, wherein the heating temperature is
5 about 42 - 48°C.

57. The method of claim 53, wherein the heating time is determined by the heating temperature according to the following relationship:

$$Heating_Time \geq 1.561 \times 10^{10} \times e^{-0.4482[Heating_Temperature]}$$

10 where the heating time is in minutes and the heating temperature is in degrees Celsius.

58. The method of claim 57, wherein the heating time is determined by the heating temperature according to the following relationship:

15 $Heating_Time \geq 1.993 \times 10^{12} \times e^{-0.5330[Heating_Temperature]}$

where the heating time is in minutes and the heating temperature is in degrees Celsius.

59. The method of claim 53, wherein the yarn is cooled for at least
20 about 15 minutes.

60. The method of claim 53, wherein the yarn is heated for a time and at a temperature sufficient to attain at least 95% of its equilibrium shrinkage.

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